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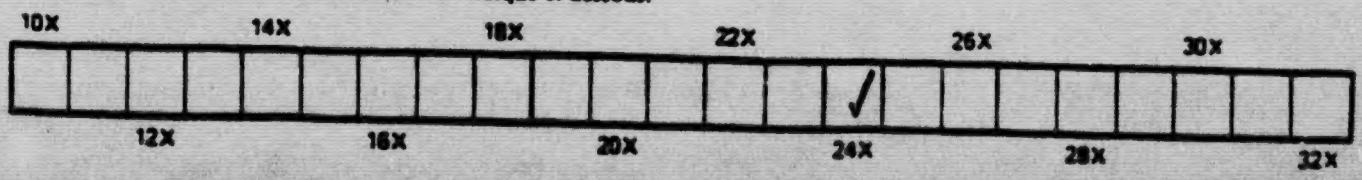

F. S. Spence

REPORT

OF

MESSRS. JACOBS & DAVIES

ON

STREET RAILWAY TRANSPORTATION

IN THE

CITY OF TORONTO

Dated August 25th, 1910.

Cap. Pam. Jacobs & Davies, Inc.

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Dated August 25th, 1910.

REPORT ON TRANSIT

30 Church Street, New York,
August 25, 1910.

To the Mayor and Council of the Corporation of the City of Toronto:

GENTLEMEN,—In accordance with instructions received with the letter from your City Clerk, dated May 25, 1910, we have the honor to submit the following report:

These instructions were as follows:

> That, after carefully considering the traffic situation in Toronto and the present street railway system, we report for the information of Council our views as to the necessary arrangements for handling the traffic, having in mind the present system and the City's rights to construct tubes in the central part and surface lines in the outlying districts, and that we will also set out our views in regard to the likelihood of such an undertaking being self-sustaining, making the estimate of the cost of construction, equipment and maintenance and probable business, and that we will express our views as to the most feasible location of such tubes and surface railways.

We have, in accordance with the above instructions, made a careful study of the conditions existing in Toronto, both as regards movement and volume of traffic, and also as regards the present routes of surface car lines. Although these conditions are naturally thoroughly familiar to you, we will set them forth in this report with the object of making the report as self-contained and self-explanatory as possible.

The surface cars within the City limits are operated by the "Toronto Railway," which provides trolley cars on the routes shown on map (Figure 1). This company was incorporated in 1892, and acquired by purchase the old Toronto City Street Railways, together with the exclusive privilege to work street railways in the City of Toronto for a term of 30 years from September 1, 1891. This privilege has since been ratified by Act of the Legislature of Ontario. The stock was increased to $7,000,000 in October, 1892, and the Toronto and York Radial Railway Company was acquired, and the Toronto Railway Company now owns the entire capital stock of the latter company. In April, 1906, the stock was increased to $8,000,000 to provide for new cars and extensions. The company also controls the Toronto Power Company, which in turn controls the Electrical Development Company of Ontario, which has its power house, etc., at Niagara Falls.

The Toronto Railway Company works 114 miles of tracks of 4 feet 11 inches gauge with 860 cars, of which 661 are motor cars and the balance trailers. The lines worked by this Company are shown in a distinctive manner for each route on the map numbered Figure 1, accompanying this report.

The following is a list of the routes operated by this Company:—

LIST OF ROUTES OPERATED BY THE TORONTO RAILWAY COMPANY.

1. Belt Line.
2. King Street
3. College Street.
4. Yonge Street.
5. Bathurst Street.
6. Dundas Street.
7. Queen Street West.
8. Bloor Street.
9. Carlton Street.
10. Parliament Street.
11. Dovercourt Road.
12. Winchester Street.
13. Broadview and Queen Street East.
14. Dupont Avenue.
15. Avenue Road.
16. Church Street.
17. Ronceavalles Avenue.

The number of revenue passengers carried in 1909 was 98,117,991, and the number of transfers issued was 38,151,596, or about 39 per cent. of those carried.

We are informed the fares paid on the lines of the Toronto Railway Company are quite favorable to the travelling public; eight tickets can be bought for 25 cents for use between the hours of 6.30 a.m. and 8.00 a.m. and between 5.00 p.m. and 6.30 p.m. At other times six tickets may be bought for 25 cents, or twenty-five tickets for $1.00. On Sundays seven tickets are sold for 25 cents.

The Toronto & York Radials (controlled by the Toronto Railway Company) are shown on the map. This system carried in 1909, 3,595,892 paying passengers and operated 72 miles of single track with 36 cars. The lines worked by this company are shown on the same map (Figure 1). This system is divided into three divisions:

(a) The Metropolitan Division from the Canadian Pacific Railway Crossing at Yonge Street and Cottingham Avenue, and going north on Yonge Street to Newmarket—Gauge, 4 ft. 8½ in.

(b) The Scarborough Division—Woodbine to York—Gauge, 4 ft. 10⅞ in. This is inside the present City limits, but outside those of 1891.

(c) The Mimico Division—From Sunnyside to Port Credit—Gauge, 4 ft. 10⅞ in.

There is another line outside the City limits called the Toronto Suburban Railway, extending to Weston, also worked electrically on the trolley system. For the year ending June, 1909, the statistics of this road were as follows:

Number of paying passengers carried during the year....	891,203
Gauge	4 ft. 10¾ in.
Length of line (single track) miles	9.84
Number of closed passenger cars	8
Number of open passenger cars	4

The company started work in 1894.

The route is from Keele and Dundas Streets through to Weston via Keele Street and Weston Road; from Keele and Dundas Street to Lambton via Dundas Street; from the corner of Keele and Dundas along Keele; then east along St. Clair to Ford Street, and from Ford Street south to Davenport Road; east along Davenport Road to Bathurst to Canadian Pacific Railway tracks.

The Grand Trunk Railway and the Canadian Pacific Railway also have an important joint station in Toronto situated just south of Front Street, west of York Street. The Grand Trunk Railway has a line skirting the lake shore in an east to west direction, while the Canadian Pacific has an east to west line also just outside the old City limits at VanHorne and Dupont Avenues.

There is a joint Grand Trunk and Canadian Pacific route through the north-western corner of the City to the Union Station, and the Canadian Pacific has a line north and south following the line of the River Don, and also connecting with the Union Station.

We have not been able to obtain any statistics as to the local passengers entering Toronto on these steam lines, as the railway companies state that they have no such figures. The suburban traffic on these lines, which in any case is very small, is therefore neglected in estimating the probable traffic in any future subway or other new means of travel, though it is likely that a certain amount of suburban travel now using the Canadian Pacific and the Grand Trunk routes would be diverted to a new road if such were provided.

There is a ferry service between Hanlan's Island resort and the City itself, which carries about 10,000 passengers per diem in the season.

The situation of Toronto is very similar to those of Chicago, Boston and many other cities in that it lies on the waterfront of a large body of water, so that all expansion of area must take place either along the shore front or away from the water, or as a combination of the two.

General considerations seem to show that future expansion will lie chiefly in a northerly, north-westerly and north-easterly direction; expansion in the last direction has not been great up to the present time, and there is now no adequate means of reaching this section. It is natural to suppose that with adequate transportation facilities this section would develop very quickly.

The traffic situation in Toronto is therefore such that it will be one growing only in the northerly radiations in relation to the business centre; also there can be little question but it will grow fast; and that in a city such as Toronto, where the beautiful is carefully looked after, unseemly congestion in the streets may be avoided even with profit financially by the adoption of subways in the not far distant future. Comparatively speaking, there is no unusual congestion of traffic, the only congestion at the present time being chiefly confined to one street, viz., Yonge Street. Congestion will of course grow, and it will be admitted that the fewer public railways on the surface of the streets the more presentable the City, and the freer also will be the surface for proper conduct of other classes of traffic, and the better able will the trolley lines be to conduct the business of distribution with comfort to the public. Your instructions desire us to consider carefully the present street railway system. We have carefully studied this system, and we find that so far as the supply of cars, the routing, and the general conduct of the system are concerned, we see no occasion to suggest any improvement. Slight exception might be taken to the number of routings on Yonge Street, and it might be possible to select parallel streets for a few of these routes, though it must be more apparent to you than to us what may be done or possible in this direction.

The quality and comfort of many of the cars, particularly of the trailers, admits of improvement. Congestion is a comparative term, and it must be admitted, in comparison with other cities, we have observed a very small proportion of the passengers have to stand, and that only for a small part of the journey. There is no reason however why Toronto should suffer any discomfort in its transit facilities because other cities do, and additional and better cars can most certainly be welcomed.

As to ordinary vehicular traffic in the streets, we do not note any extraordinary congestion with the exception of the vicinity of the lower end of Yonge Street, and we wish to draw attention to the fact that in many cities certain classes of heavy and slow moving vehicles are prohibited the use of certain streets either entirely or during certain hours of the day. Some such regulation in the case of Toronto might be of material benefit.

It seems that conditions attaching to the franchise do not permit of an understanding between the City and the Railway Company whereby passengers may—on a single 5-cent fare—obtain transportation within a radius of say from 6 to 8 miles from the City Hall. On the other hand, Toronto, being about 10¼ miles in extreme length by 3¾ miles in width, is a most unusual City in the fact that for its population it extends over a very large area, making it, what it seems to be, an exceedingly open, attractive and healthful city, but for that very reason it makes transit to some extent more expensive to operate because of longer distances to travel.

The following table shows the latest returns of the population of the City, ward by ward, the density per acre, and the average annual increase for the period 1906 to 1910:

Ward.	Population.		Average Annual Increase.
	Total.	Per Acre.	1906-1910.
			Per Cent.
1	55,783	13.38	11.01
2	46,880	26.20	2.96
3	45,503	29.92	3.18
4	63,406	29.73	3.51
5	59,875	27.61	6.80
6	60,032	17.25	9.72
7	12,846	8.56	4.85
Totals and Averages	344,275	20.60	6.00

In order to show the above information more clearly, map (Figure 2) is appended to the report, and on this the various wards and their corresponding populations are shown.

The above table indicates that the population of the City is increasing more rapidly in the outlying districts, viz., the First, Fifth, Sixth and Seventh Wards, than nearer the heart of the City. It is probable that in the central area the resident population is already at a standstill or even diminishing, although owing to the way in which the City is divided into wards consisting of north and south belts across the City with a much denser population at one end than at the other, the statistics by wards do not actually prove this to be the case This condition of diminishing or stationary resident population at the business centre is always found after a city has arrived at a certain stage of development, and is a natural outcome of increased population and business and improved means of transportation. The larger and older the city the more marked it becomes, and is especially evident in London,—and in New York, though to a less extent.

The density of population in Toronto is rather low, varying from 8.06 per acre in the Seventh Ward to 29.92 in the Third, while the average is 20.6 over the whole City.

The borough of Manhattan in New York City has an average density of 150 per acre and a maximum of 700 per acre in the lower East Side, but this borough of the city is in a sense the antithesis of Toronto and almost devoid of true home life—and to preserve and continue this condition in Toronto it is probably better to build transit lines than large apartment houses.

In the central area of London the density is 148 per acre, and in the city as a whole it is 54.

The following table gives the population, area and average density of population of some of the chief European, American and Canadian cities:—

Name.	Area, Acres.	Population Number.	Density of Population No. per Acre.
London	440,320	7,200,000	16.3
New York	206,420	4,300,000	20.7
Paris	115,712	3,900,000	33.7
Berlin	76,288	3,206,000	42.1
Chicago	120,576	2,100,000	17.4
Philadelphia	81,152	1,500,000	18 5
Boston	27,072	1,300,000	43.3
Montreal	27,520	476,000	17.3
Toronto	16,750	345,000	20.6

These figures give the average density of population within the entire administrative area of each city, which in some cases (eg., New York), includes large areas of what is really open country.

In order to forecast what the probable future growth of population in Toronto will be within the next ten years or so, it is necessary to look back over the past few years.

The present population of the City is stated to be 344,275, and the average annual increase during the last five years has been 7.6 per cent., or at an average rate of 6.65 per cent. per annum, while for the last 10 years it has increased at an average rate of 5.79 per cent. per annum.

For the purposes of comparison and to form an estimate of the probable growth a diagram (Figure 3) is shown, on which is plotted the growth of population of the chief cities on the Great Lakes, as well as that of Toronto. The general conditions of the cities on these lakes are so similar that a better forecast of the future can be made by considering them all together than by considering one. It will be seen from this diagram that there has been a remarkable similarity in the rate of growth of these cities. Eliminating Chicago (the largest) and considering the following cities in the United States, viz., Cleveland, Buffalo, Milwaukee, Detroit and Toledo, we find that these five cities have for four decades maintained about the same relative position as regards population, and have grown at about the same rate as one another, but while they continue to increase, the rate of growth diminishes as their size increases.

Keeping this in mind, and considering that the country tributary to these United States cities is now in a higher state of development than the not less valuable area tributary to Toronto, and that the latter is now developing faster than the corresponding areas in the States, it would seem fair to assume that the rate of growth of Toronto during the next decade or so would be rather greater than these five cities, and as their recent average

rate has been 3.8 per cent. per annum, a line has been drawn on another diagram (Figure 4) to show a probable growth of 5 per cent. per annum in the population of Toronto. According to this the population would be about 560,000 in 1921, and about 920,000 in 1931.

There is another subject besides that of mere population that has to be kept carefully in mind in estimating probable future travel in a city, and that is the fact that the travel per head increases faster than the population. This result is brought about not only by the increase in size in cities themselves, but by the improvement and acceleration of transportation service, which has a very marked influence. In the old days when transportation was much inferior in speed, comfort, and reliability, it was difficult for a town to expand above a certain size, and if the geographical position of a town made its expansion inevitable, the growth was met by the addition of a number of adjacent towns, each one of which was a self-contained unit. The best example of this is London, which, until quite recently, was not so much one whole city, but consisted of the City of London, surrounded by a number of dependent but self-contained towns such as Lambeth, Westminster, Brompton, Kensington, Islington and so on.

In those days everyone lived over his shop or near his place of business, his church or his places of amusement; and the amount of transportation required under those conditions was small. Growth of business called for improved transportation; improved transportation in turn altered the methods of living of townspeople; and now the tendency is for certain portions of the city to be devoted to factories, portions to banking and commerce, portions to shops, other portions to places of amusement, and still others to residences: and the amount of transportation required under these conditions has increased and is increasing enormously.

This increase in the amount of transportation required becomes evident when we consider the number of rides per inhabitant per annum in various large cities. We find at once not only an increase as population increases, but also a large increase in the number of rides per head as transportation facilities are increased and improved.

Take for example London, with its
56 rides per head per annum in 1881.
129 rides per head per annum in 1901, and
348 rides per head per annum at present, since the development of the underground electric system.

There is also New York, with its
167 rides per head per annum in 1884,
300 rides per head per annum at the present day, without the ferry and suburban steam railway passengers, and its
406 rides per head per annum with these included.

The following table gives further data regarding this important feature of the problem:

Town.	Year.	Population.	Rides per Head.	Average Increase % per Annum.	
				In Population.	In No. Rides per Head per Annum.
London	1867	2,900,000	28		
	1881	4,767,000	56	4.6	7.2
	1901	6,581,000	129	1.6	6.5
	1904	6,847,000	200	1.3	18.2
	1910	7,200,000	348	0.5	12.3
New York	1884	1,935,000	167		
	1891	2,476,000	242	4.0	1
	1897	3,114,000	246	4.3	0.27
	1902	3,631,000	289	3.3	3.5
	1907	4,152,000	320	2.9	2.2
Philadelphia	1865	600,000	41		
	1875	750,000	116	2.5	18.8
	1890	1,046,000	157	2.6	2.37
	1900	1,293,000	226	1.4	4.39
	1909	1,600,000	289	2.6	3.1
Boston	1899	865,000	270		
	1900	900,000	277	4.05	2.6
	1909	1,026,000	430	1.56	6.14
Montreal	1901	268,000	227		
	1909	476,000	266	9.7	2.5
Toronto	1871	59,000			
	1881	96,000		6.3	
	1891	181,000		8.8	
	1901	208,000	192	1.49	
	1910	345,000	280	7	5.2

This information is plotted in diagram form and shown in Figure 5 for various cities, and in greater detail for London in Figure 6.

Another means of comparison may be had from studying the extent of exclusive lines of travel provided in other cities, in relation to the population served, and such other statistics as will show the relative situation of Toronto as compared with other places which have found it necessary to provide themselves with "exclusive lines of travel," by which term we designate lines—whether elevated, subway or surface in private right of way—built for the exclusive use of passenger cars on rails in contradistinction to lines laid in the public streets.

The following table gives shortly some main statistics bearing on this question, and at the end of this table have been shown relations to a subway proposal for Toronto we make later in this report.

Town.	Length of Exclusive Transit—Miles of Single Track.	Population.	Population per Mile of Single Track.	Cost of Exclusive Transit Lines per head Population.	Revenue of All Transit per Head.
				$	
Greater London	1,320 (*a*) 332 (*b*)	7,000,000	5,302 21,000	41.00	.....
New York	326.1	5,000,000	15,500	72.00	....
Boston	48.8	975,000	22,300	33.00	14.80
Paris (in operation and proposed)	177.8	3,900,000	21,900	27.50	.....
Philadelphia	16.5	1,500,000	91,000	10.50	12.10
Toronto (proposed Yonge Street Route)	3.5	345,000	98,500	16.00	.....

(*a*) Main lines carrying suburban traffic.

(*b*) Only subways, deep and shallow.

As an illustration of how travelling accommodation has increased per capita of population, the following approximate figures relating to London may be quoted:—

Year.	Population.	Population per Single Mile of Exclusive Railway.
1845	2,000,000	33,600
1860	2,800,000	20,300
1880	3,800,000	8,820
1900	4,600,000	9,250
1910	7,000,000	5,300

Cost of Operation:

The cost of operation in relation to gross revenue on subways proves generally to be lower than on surface lines. In the case of New York—with its enormous distances and its huge and generally congested population—this has proved to be particularly the case, though it must be recollected that these conditions are in a sense peculiar to New York, and should be applied to the case of Toronto only with discount. On the New York Interborough Railroad (subway division) for the nine months ending March

31, 1910, the receipts per car mile have been 27.28 cents, and the cost operation (inclusive of rental and depreciation, but exclusive of taxes), h been 9.58 cents per car mile, making the cost of operation about 35 per cen of the gross receipts. On the elevated division of the same road the receipt have been 23.09 and the expenses 10.0 cents per car mile, the percentage cost of operation being 43.3 per cent. The traffic on these lines is enormou being about 170,000,000 per annum or 3,260,000 passengers per annum pe mile of single track on the subway division and about 250,000,000 per annum or 2,450,000 per annum per mile of single track on the elevated division,— and no transfers are given on the lines of any other system, nor between the elevated and subway systems of the Interborough Railroad itself.

On the Hudson & Manhattan R. R. in New York (the McAdoo System) the receipts have been 43.61 cents and the operating expenses (including depreciation and taxes) 17.35 cents per car mile, the percentage of costs of operation being 39.74. The number of passengers carried by this line is about 50,000,000 per annum, or 3,350,000 per mile of single track.

The Boston system of exclusive transit lines consists of 33.7 miles of single track with 16.5 miles more under construction. When this new work has been finished the total expenditure will be about $30,000,000, exclusive of power house and equipment, or about $31 per head of population, with a population of about 20,000 per mile of track. Were Toronto to make a similar expenditure in proportion to population, say, $10,600,000, this would afford the City about seven to eight miles of subway, or 14 to 15 miles of single track of exclusive transit; this is a mileage sufficient to give a layout as per diagram (Figure 7). Boston, with these exclusive facilities, is making a good return on a system which also shares most liberally on a 5-cent fare with the surface lines, but is situated in a territory which, in comparison with Toronto, is much more fully developed.

The elevated lines in Boston were built and are owned by the Elevated Railway Company, while the subway lines (excepting those under construction to Cambridge), were built by the City and are leased by the Elevated Railway Company. The transfer system in Boston is very liberal, but the profits are good, returning 6 per cent. dividends, after paying—directly and indirectly—about 12.4 per cent. of the gross revenue to the public, including a rental of 4 per cent. on the cost of construction of the subways. Please carefully note this is the return on the whole system—subway, elevated and surface—and there is no way of separating the revenues from these various sources.

The income derived from the Philadelphia system has been disappointing, as before the construction of the subway the number of passengers carried on the surface lines was increasing at a rapid rate, and the subway was financed on the basis that this increase would continue. When it was opened in 1907 the severe business depression was in existence, and although the subway did and does a large business, the total travel on the subway, the elevated and the surface lines (all operated by the one company) has not increased beyond the figure prior to the opening of the subway. However,

the net earnings of the subway and elevated systems are enough to meet the interest on the investment.

Transfers from subway and elevated to surface lines and *vice versa* are given at certain restricted points only, and no such transfers are given in the central part of the City. Besides, a large proportion of the suburban passengers are handled by the main lines—the Pennsylvania Railroad and the Reading Railroad—which give excellent and constantly improving services to attractive suburbs (*e.g.*, in the year 1909 the Pennsylvania Railroad handled slightly over 29 million people on its lines to and from the City of Philadelphia).

It is further helpful to consider this question by citing in further detail the transit facilities provided in certain other cities and figures of the return made on the investments. It is evident these miscellaneous figures can not be applied without reserve to the case of Toronto, as every city has its own characteristics, but they are given as an indication of the general trend of results:

Paris Subway:

Population served	2,790,000
Length subway, miles single track	60
Rush hour headway, minutes and seconds	2:33
Length of station platforms, feet	246
Average speed of operation, miles per hour	12
Average fare, cents	2.7
Total cost, construction and equipment	$62,252,000
Return per annum, almost	7.5%
Cost of construction and equipment per mile of single track (about)	$1,000,000
Cost of construction alone, mile of single track	676,000
Cost of equipment alone, mile of single track	324,000
Average length of ride, miles	2½

New York Subway: (Interborough Rapid Transit Co.)

Population served	2,570,000
Length of subway, miles single track	61
Rush hour headway, minutes	2
Length of station platform, feet	350
Average speed of operation, miles per hour	18
Average fare, cents	4.99
Total cost, construction and equipment	$87,938,000
Return on investment, about	7%
Cost of construction, per mile single track	$990,000
Cost of equipment, per mile	433,000
Total cost per mile single track	1,423,000
Average length of ride, miles	5½

Hudson & Manhattan Railroad: New York City.

Population of Greater New York, about	5,000,000
Length of track, miles (single track)	13.
Rush hour headway, minutes	1½
Length of station platforms, feet	350
Average speed of operation, miles per hour	20
Number of passengers per annum, about	50,000,000
Average fare, cents	5
Total cost construction and equipment (including cost Terminal Building), about	$110,000,000
Total cost per mile of single track	$8,087,000

Boston Elevated Railway Company (1909):

Population served	970,000
Length of track, miles	488
Made up as follows:	
Surface track, miles 454	
Subway track, miles 10.5	
Elevated track, miles 24.1	
Total revenue passengers carried (1909)	281,000,000
Total investment in entire system	$67,000,000
Company's subway, cost, construction and equipment (about)	$18,707,000*
Return paid by Company to shareholders per annum	6%
Average fare per revenue passenger, cents	4.99
Average speed, miles per hour	13

Philadelphia Subway and Elevated:

Population served	1,600,000
Length of station platforms, feet	350
Street length of system (double track) miles	7.4
Total cost construction and equipment	$27,500,000
Average speed of operation, miles per hour	15½
Rush hour headway, minutes	3½

Glasgow District Subway:

Population served, about	750,000
Length of line, miles single track	14
Total receipts	$340,200
Working expenses	$187,400
Net receipts	$152,800
Percentage proportion of expenditure to total receipts	55%
Average fare (about) cents	1.9
Passengers carried per annum (about)	15,068,622

* The City has spent in constructing subways in Boston about $20,000,000, in addition to the sum stated here, which was expended by the Company itself. The Company pays rent to the City for the use of such subways as the City built.

The capital of this company is $6,325,000 by shares and stock, and $840,000 by loans. The return is about ¼ per cent. per annum on the $3,650,000 ordinary stock and 4 per cent. per annum on the $2,675,000 preferred.

This Company is interesting as being one which, though carrying only a few passengers per annum and at a low average fare, nevertheless manages to make both ends meet.

Liverpool-Mersey Railway Co. (1909). Deep Level Tunnels under Mersey River:

Population served—		
Liverpool	746,000	
Birkenhead	124,000	
		870,000
Length of line, double track, miles		4¾
Headway (constant), minutes		3
Train miles run per annum		329,000
Receipts per passenger, cents		3.34
Total cost of construction and equipment		$17,540,000
Working expenses, percentage total receipts		63%

This is practically a deep-level tunnel and the company is not financially successful, only paying interest on part of its debenture stock.

London—Central London Railway (Deep Tube):

Length of single line, miles	13
Proportion of total expenditures to total receipts,—	
1901	54%
1902	52%
1903	56%
1904	54%
1905	54%
1906	55%
1907	58%
1908	50%

NOTE.—Not less than 10% of this is absorbed by the operation of elevators between railroad level and street level.

Capital $19,100,000

The company pays about 3% per annum on its ordinary stock.

City and South London Railway (1909)—Deep Level Subway:

Length of single line, miles	16
Gross earnings	$ 830,000
Car mileage	6,895,000
Cost per train mile, cents	5.72
Cost per passenger, cents	1.79
Cost of operation	$394,000
Cost of operation as percentage of gross earnings	47.4%
Cost of lift operation as percentage of total operating charge	12.3%

The capital of the Company is $14,460,000; the Company pays 1½ per cent. to 1¾ per cent. per annum on its $7,200,000 ordinary 5 per cent. on its $3,950,000 preferred stock, and 4 per cent. o $3,310,000 debenture stock.

In order to show in a condensed form the percentage proportion of e diture to total receipts as experienced by some of the electrically oper lines in Great Britain, we append the following table referring to result the year 1908:

Name of Line.	Miles of Single Track.	Total Working Expenditure.	Total Receipts.	Net Receipts.	Percen Opera to To Receip
Deep Level Tubes		$	$	$	
Baker St. & Waterloo..	8	436,000	820,000	324,000	53
Central London.....	14	902,000	1,800,000	898,000	50
Charing Cross, Euston & Hampton	16	550,000	890,000	340,000	62
City & South London..	16	406,000	850,000	444,000	48
Grt. Northern & City..	6	218,000	414,000	196,000	53
Grt. Northern, Piccadilly & Brompton...	20	713,000	1,410,000	697,000	51
Waterloo & City	4	88,200	154,000	65,800	57
Mersey	8	364,000	500,000	136,000	72
Shallow Subways					
Metropolitan (London)	92	2,400,000	4,150,000	175,000	58
Metropolitan District (London)	50	1,535,000	2,500,000	965,000	61
Metropolitan District Extensions (London)	4	154,000	344,000	190,000	74
Whitechapel & Bow..	4	248,000	303,000	55,000	83
Overhead					
Liverpool Overhead.	18	291,000	365,000	74,000	80

In the case of the deep level tubes, the expense of the lift or elevator operation is quite a factor and very constant at about 10 per cent. of the total operating expense.

A statement is also appended of the amount of stock and share paid-up capital of most of the electrical railroads in Great Britain as in 1908, showing the amount of return on the investment. This will serve to show that most of these undertakings in Great Britain (chiefly London) are not paying a very handsome return on the investment.

STATISTICS OF STOCK AND SHARE CAPITAL AND RETURN VARIOUS ELECTRICAL RAILROADS IN GREAT BRITAIN AT THE END OF 1908.

Name of Line.	Paid-up Stock and Share Capital.			
	Ordinary.		Preferred.	
	Amount. £	Rate of Dividend Paid.	Amount. £	Rate of Dividend Paid
Baker St. & Waterloo	1,444,000	3	3,210,000	4
	6,950,000	¾		
Central London	9,200,000	3½	nil.	
	2,700,000	4		
	2,700,000	2½		
Charing Cross, Euston & Hampstead	19,800,000	nil.	nil.	
City & South London	7,200,000	1¼	3,950,000	5
Great Northern & City	3,790,000	nil.	nil.	
	3,790,000	nil.	nil.	
Great Northern, Piccadilly & Brompton	22,800,000	¾	1,725,000	4
Liverpool Overhead	2,440,000	nil.	583,000	5
			170,000	2½
Mersey	6,900,000	nil.	3,160,000	nil.
Metropolitan Ry	27,800,000	¾	29,000,000	3½
Metropolitan District	15,800,000	nil.	14,200,000	5

In most of the above cases, the total paid-up capital is increased by capital raised by loans and debenture stock, which is not included in the above statement.

The following table gives statistics of some electrical tramway chiefly in Great Britain:

STATISTICS OF ELECTRIC TRAMWAY LINES IN VARIOUS CITIES, 1909.

City.	Population Served.	Passengers Carried.	Average Fare per Passenger.	Average Speed per Hour.	Miles, Single Track.	Total tal pendi
			Cts.	Miles.		$
London	7,000,000	345,000,000	2.14	8½	170	39,200
Glasgow	1,050,000	222,000,000	1.93	8	188	16,100
Manchester	850,000	155,000,000	2.32		181	9,000
Sheffield	463,000	76,000,000	1.80	7	71	6,200
Birmingham	558,000	78,000,000	1.80	7½	57	5,000
Bradford	337,000	47,500,000	2.32	7	99	4,500
Salford	350,000	46,000,000	2.48	7½	75	3,475
West Ham	43,000	34,000,000	1.60	6½	27	2,500
Montreal	500,000	95,376,000	2.91			15,800
Toronto	345,000	98,000,000	3.855			15,000

City.	Gross Receipts.	Percentage of Operating Expenses of Total Revenue.	Average Operating Expenses per Car Mile.
	$	Percentage.	Cents
London	7,650,000	57	11.2
Glasgow	4,350,000	56½	10.8
Manchester	3,830,000	61	10.4
Sheffield	1,410,000	62½	10.34
Birmingham	1,430,000	64	10
Bradford	1,190,000	69½	10.2
Salford	1,150,000	65	8.8
West Ham	560,000	67	10
Montreal	3,875,000	58	16
Toronto	3,926,000	51	

The following is a table showing in condensed form statistics as to the operating expenses of the main groups of lines of travel in and about New York City for the year 1908, divided broadly into "elevated and underground" (what we have termed "exclusive transit" and "surface lines"):

STATISTICS OF OPERATING EXPENSES ON LINES OF EXCLUSIVE TRAVEL IN NEW YORK, YEAR 1908.

Name of System.	Gross Receipts	Per Car Mile in Cents.	Operating Expenses in Dollars.	Operating Expense as percentage of gross receipts.
Hudson & Manhattan R. R.	$ 222,416	37	229,680	103 (note)
Interborough R. T. Co.	24,699,595	10	10,722,694	43
Brooklyn R. T., El. Div.	7,350,582	17	4,742,935	64
Totals and averages, Elevated and Underground	32,272,593	21	15,695,309	49
Manhattan Surface Lines	18,731,995	22.85	13,873,146	74
Bronx Surface Lines	2,135,134	15.75	1,822,076	85
Brooklyn Surface Lines:				
Brooklyn R. T.	12,152,115	18.57	7,927,519	65
Other roads	1,645,801		1,304,645	79
Queens Electric Road	1,526,032	17.62	1,237,128	81
Richmond Electric Roads	563,622	17.01	488,407	87
Richmond Steam Roads	915,355	22.66	739,210	81
Totals and averages, Surface Roads	37,669,464	15.61	27,392,131	72

NOTE.—In the last report of this road, April 13, 1910, this percentage is as low as 39; at the date of the table (1908), the line had only just been opened.

It may also be noted, the expense of operating per car mile (though this is a rather inconstant factor) works out as follows:

On underground and elevated .....11.3 cents.
On surface street railways .....20.0 cents.
On steam railways .....23.0 cents.

The foregoing facts have been collected and presented in this report as a means of judging whether in the case of Toronto it is desirable to provide at this stage some additional relief, other than street railway additions, to the present and future congestion of traffic, and if so what would be the best means of attaining such an object.

First of all, one must clearly dissociate one's mind from the somewhat natural idea that only cities of the largest size are called on to provide themselves with what we call "exclusive lines" of travel, by which is meant, as

previously defined, lines—whether elevated or subway—built for the
sive use of passenger cars on rails, in contradistinction to lines laid
streets, which are not for their exclusive use and must be used in c
by vehicles, pedestrians, street cars, etc.

Further, the topographical and geographical conditions of a ci
gether with the social customs and earning power of its inhabitants
make the construction of exclusive lines of travel within it desirable,
though that city be of comparatively small size, while in a much large
such provision may be unnecessary.

To illustrate this, taking the largest cities of the world, and numb
them in the order of their population, we find that in the first twenty-nine c
ranging in population from 600,000 to 4,600,000, exclusive lines of travel
been provided in eleven of them, namely, the first, second, third, fifth, s
eighth, twelfth, twenty-second, twenty-third, twenty-fourth and twenty-ni
By this it will be seen that it is by no means the first eleven out of
twenty-nine that have found the streets alone inadequate to carry the tra
though this of course is by no means the only reason for adoption of exclus
transit.

We observe Toronto in comparison with most cities, though not
obtains a good service at comparatively low rates. We see the suburb
condition in which Toronto finds itself owing to the Toronto railways havi
the sole right to work street railways within the old City limits until 19
We know the existing—but not meantime serious—congestion of traffic
the lower end of Yonge Street. We know the inevitable increase of popul
tion and the equally inevitable and quicker increase of travel per head
population. We know the growth of the City pushes the suburban residenc
further and further away from the centre, with consequent increase in th
distance that each ride takes the rider; and we know the danger which an
restriction to the growth of traffic has upon the healthy growth of a city, fo
as growth of population means growth of travel, so the converse is equall
true, that restricted methods of travel mean the driving away of population
that would otherwise be attracted. We know that Toronto has even now a
high number of rides per head per annum, and one is forced to the conclu-
sion that Toronto City is wise in grasping time by the forelock in at least
seriously considering the provision of some means of exclusive transporta-
tion, which will result in an increase of travel, population and business
prosperity, and which—if not now necessary—can later on be instituted by
instalments to form a well-considered and comprehensively designed rapid
transit system, using the term in its strict sense, and not, as sometimes
seems to be the case, applying it to cases chiefly characterized by a striking
lack of both rapidity and system.

As an illustration that perhaps Toronto is not acting precipitately in at
least considering some exclusive lines of travel, we may cite the case of
London, which in 1863 provided itself with its first subway, viz., from Pad-
dington to Farringdon. The population of London was then about 2,400,000
and the number of rides per head per annum was about 24; the product of

these is 57,600,000. The present population of Toronto is about 345,000, and the rides per head per annum are 280; the product of these is 96,600,000, or 1.7 times as great now in the case of Toronto as it was then in the case of London.

In the year 1874 New York City found it necessary to provide itself with some means of exclusive travel, and installed the beginning of the elevated railway system. At that time the population of the City would have been about 1,617,000, and the number of rides per head about 52. The product of these is 84,000,000, so that the ratio of the corresponding product in Toronto's case to the product in New York's is as 1.15 is to 1.

It may now be in order to set out the various kinds of exclusive travel lines which may be constructed, and point out briefly the advantages and disadvantages of each, and then draw the conclusion as to what we consider to be best fitted for Toronto.

First—The Deep Level Subway:

Access to the stations in this type is gained by means of elevators. The various "tube" railways in London are an illustration of the possibilities of this type. The advantages of this kind of subway are chiefly those of construction, since there is much less interference with the cellars, pipes, sewers, etc., which lie immediately below the surface; also, as these tubes are driven by the shield method, compressed air can be applied, and for heavily water-charged ground or subaqueous work this system is the best yet devised. The points against this system are the depth below the surface, compelling passengers to descend to and rise from the trains in elevators, and the cost of working the elevators, which forms a serious part of the operating expense.

Second—The Shallow Subway:

Access to the stations in this type is gained by means of stairs from the street surface, the line being placed so that the rails are as near as possible to the surface of the streets under which they run. This type is far more accessible than the deep level tube, but it is more expensive to build; this is seen by comparing the relative cost of the deep level tube lines and those of the shallow type which have been built in London. The tube lines in London have cost between $2,916,000 and $3,402,000 per mile of double track to build, while the shallow subways have cost between about $3,669,000 and $4,495,000 per mile of double track. In this connection it may be remembered that most of the London shallow subways having been built in the days of steam traction, have had expensive ventilation systems that have added to their cost. Greater disturbance to the street during construction is caused by this type than by the first, and altogether it may be said that while the constructional difficulties are greater, the transit facilities offered are much better.

Third—Elevated Railways:

This means of exclusive travel has the merit of cheapness of construction, the cost being about one-fifth of that of subways. Elevated railroads require neither lighting during the daytime nor ventilation; they are, on the other hand, a great nuisance in busy streets on account of the obstruction of space caused by the supporting columns, and they are also great obstructions to light and are usually very noisy. They are also open to the weather, and are thus subject to delay and even breakdown in times of heavy winter weather.

Fourth—Surface Lines on Private Right of Way, with over or under Crossings on Streets.

This form is suitable for sparsely settled suburban dis[illegible], but in city areas the real estate and land damages make the cost prohibitive.

You are aware it is unnecessary that any city providing itself with means of exclusive transit should tie itself down to one and only one of these various types. Each zone of territory may have one of these types exhibited.

In thickly populated districts a subway of the deep or shallow type is to be preferred. From the passenger's point of view the shallow subway is to be preferred in all cases. From other points of view the deep level subway may, in certain situations, be imperative, as for example, in crossing a river whose bed is in water-bearing ground, or in passing through streets the portion of which immediately below the surface is very largely taken up with expensive structures. We consider that in Toronto conditions are favorable to the shallow subway type.

The elevated structure is of use in sparsely settled districts, and it may be better in some cases to build such where the high cost of subways would put the latter out of the question. The early elevated roads were built entirely of structural steel, and were both noisy and unsightly to the last degree. By encasing the steel work in concrete and providing a solid floor with a ballast track, noise can be reduced and the structure improved in appearance. The whole structure may also be built in concrete or masonry and will look much better than a structure of steel.

The surface track on private right of way passing under or over crossing streets is more applicable to country still more open and more sparsely settled than that where the elevated type would be used.

In discussing possible lines of exclusive traffic for Toronto, we confine ourselves to the shallow type, as conditions are favorable to this type. Other types can be used in the future, if occasion warrants it, for extension into the surrounding country.

Having considered these various provisions for exclusive traffic and conditions (geological and otherwise) which prevail in Toronto, both as to

the Toronto Railway Company and the existing and prospective traffic and population, we are of the opinion that it is not wise for the City to adopt a subway system of this type within the City limits solely in conjunction with a system of radial lines outside the City limits of 1891, with the object of reaching as much territory as possible now unprovided with transit facilities.

Subways should be provided with stations at long intervals, except in the heart of the City, if the surface lines act in conjunction as short distance distributors and feeders, while the function of the subways is to carry the people rapidly between the suburbs and the congested area in the heart of the City. A subway can not be operated to the best advantage financially or with a view to the best serving of the public if it is operated only in conjunction with radial lines.

We have sketched out two or three alternative routes for subways which may be considered by you on basis of independent and co-operative operation with the existing street railways within the City limits.

These plans may first be generally outlined, and following this will be given estimates of the cost of construction of the system. These estimates include the following items: construction of subways and stations, installation of tracks, signals, electrical equipment and lighting, supply of rolling stock, provision of car yard and repair shops, and cost of converter station and land.

No particular locality is assigned for these surface provisions, as it is assumed land can be obtained at about 50 cents per square foot in convenient localities.

The estimates of cost also include contractors' profits, engineering costs and carrying charges during the construction period.

In this preliminary layout of subways the stations are spaced with the object of operating them in conjunction with the surface lines, and not as competitive schemes, with the exception that consideration has been given to the Yonge Street line operating as an independent venture in connection with new radials under the same ownership as the subway.

We may say in making these estimates of cost no credit has been taken for the material excavated during the progress of construction, and used for reclamation purposes. It is of a suitable character for this, and should it be thus used the subway scheme might at least be credited to the etxent of the cost of the disposal of the material. It would seem a subway scheme in the case of Toronto should provide for using this material in a reclamation scheme on the lake front.

Following the estimates a discussion of the probable earnings of each scheme will be given.

We have made observations as to the relative use of the various transfer points on the surface lines in the City and have embodied this information in diagrammatic form (Figure 8) which we have used in locating proposed stations.

Scheme No. 1—Shown on Map, Figure No. 9.

This is what we consider the most ideal subway system following the lines of the present streets that could be laid out; that is to say, it is comprehensive and would form part of a "circular" system which the City may require at some future date. This circular system would be a complete subway ring, with its northern part along St. Clair Avenue and its lower eastern portion passing through Broadview, Danforth and Woodbine, while its western portion would find its way from the foot of Yonge Street to Keele terminus via the busiest streets of Wards 4, 5 and 6. The northern portions of this circular system would be outside the City limits of 1891, and radial lines feeding and being fed by the circular rapid transit subway would expeditiously convey passengers during the day and perhaps goods and merchandise during the night into the heart of the City. We have shown on the map (Figure No. 9) the route for this system. The portions for which estimates have been made are shown in full lines, while the portions which would complete the circular system are shown in dotted lines. It will be seen that the scheme is divisible into three main portions.

(a) A line down Yonge Street from St. Clair Avenue to Wellington Street.

(b) A line from Broadview and Danforth to Front and Yonge.

(c) A line from Front and Yonge to Dundas and Keele at the north-west corner of the old City limits.

Our estimate for this scheme, considered and constructed as a whole, is $23,470,000, including equipment, car yards, converting station, land, contractors' profits, engineering, and carrying charges during construction; of this amount $16,755,000 is for construction of subways and stations and installation of track, and $903,000 is for carrying charges during construction. If the project is divided for the purpose of construction and operation into three component parts—the arms radiating from near the south of Yonge Street—the cost would be somewhat higher, and the estimate comes to

For Section (a) $6,100,000, of which $4,180,000 is for construction and track, and $232,000 is for carrying charges.

For Section (b) $11,350,000, of which $8,187,000 is for construction and track, and $436,000 is for carrying charges.

For Section (c) $6,235,000, of which $4,189,000 is for construction and track, and $240,000 is for carrying charges.

This makes the total cost of scheme 1, considered as three sections, $23,685,000.

The subway system just outlined would be incomplete without an additional system of radial surface lines outside the City limits of 1891. The following routes may be recommended:

(1) Lines to the north from St. Clair Avenue on Bathurst Street and Lakeview Avenue.

(2) Lines to the north-west from Keele Terminus via St. Clair Avenue and Jane Street.

(3) Lines to the east from Broadview and Danforth Terminus, passing along Danforth with brahches to the north via Leslie Street and Woodbine Avenue.

This would open up a large territory north of Danforth Avenue. These suggested radial routes are shown in blue on Figure 9.

Consideration of the exact routes of these radial lines can be matured later, the main point being to extend them into territory now unserved.

Scheme No. 2—Shown on map, Figures Nos. 10, 11 and 12, on which the red lines indicate the subway routes, and the blue lines the suggested routes for susidiary radial lines.

This scheme is much less comprehensive than the first one, and one that does not go to the heart of the matter in the same way as Scheme No. 1, but which may be considered of some immediate benefit, and at the same time eventually might form part of the scheme outlined as Number 1.

This scheme consists of a line running up Yonge Street from near the Union Station to St. Clair Avenue.

We have selected three alternative routes for this, and our object in doing so has been to see how low a cost could be reasonably expected for such a line.

The three routes are as follows:

(a) On Yonge Sereet.
(b) On Teraulay Street.
(c) On victoria Street and Yonge Street.

The object of (b) and (c) is to pass through as much length as possible in streets that have no car lines on them, thus reducing the cost of construction.

Scheme 2 (a):

There are seven stations on this line, and our estimate for the work, as before, including equipment, contractors' profits, engineering, land, and interest during construction, is $6,762,000, of which $4,777,600 is for construction of subways and stations and installation of track, and the amount included for carrying charges is $260,000.

3,037,600
1,624,400

Scheme 2 (b):

By Teraulay Street, is a line following a route by which, in order to save cost, Yonge Street is avoided as much as possible.

There are six stations on this line, and the estimate of the cost, inclusive of equipment, land, contractors' profits, engineering, and interest during construction, is $5,540,000, of which $3,781,000 is for construction of subways and stations and installation of track, and $213,000 is for carrying charges during construction.

It will be seen that this scheme aims at tapping the district between the Metropolitan and the Weston lines in Toronto Junction.

Surface lines would be suggested north into St Clair Avenue and north of that again via Forest Hill Road, Vaughan Road, Bathurst Street, etc.

Scheme 2 (c):

The next scheme follows Victoria Street, and like the previous one, avoids the expense of passing under the busiest portion of Yonge Street.

There are seven stations on this line, and the estimate for the work, including equipment, land, contractors' profits, engineering and interest during construction, is $6,825,000, of which $4,819,000 is for construction of subways and stations and installation of track, and $263,000 is for carrying charges.

It will be noticed that the extra length over Scheme 2 (a) does away with the saving effected by not passing under Yonge Street for its entire length, while the route itself is not so good. Therefore, as between Schemes 2 (a) and 2 (c) the former is preferable.

As an addition to either of these routes, we merely suggest the consideration of an eastern branch on the line of Bloor Street. This necessitates the building of a double-decked viaduct to connect Bloor with Danforth, and crossing the Rosedale Valley Road and the valley of the Don. This is not at all a cheap piece of work, as the viaduct crossing is expensive; however, it links up Bloor and Danforth—which might be a desirable and logical thing to do as a civic improvement—and serves to open up the district north of Danforth. The estimate for this work, not necessarily an adjunct to the simple Yonge Street scheme, is $2,613.000, including contractors' profits and engineering; of this sum $100,000 is for carrying charges and $1,400,000 is for the viaduct. This viaduct and a possible subsidiary surface line along Danforth Avenue is shown in Figure 10.

Scheme No. 3—Shown on Map (Figure 13):

Having outlined certain suggested routes, following the present layout of the City streets, we may make one more estimate.

We have been supplied with a map of the City on which are shown two proposed main diagonal streets, going respectively north-west and north-east from near the foot of Yonge Street.

We believe that the wisdom of this proposal is indubitable, bearing in mind the fact that the present layout of the streets is perfectly suitable for those wishing to travel due north, due east or due west, but as the City of Toronto must expand in all directions some diagonal routes would seem to be strongly needed, and of course the longer they are delayed the more expensive this surgical operation will become. The rectangular system of town planning has its own advantages—and especially so in cases where a city, by reason of its geographical position, can expand narrowly only in one direction—but in a wide-spreading city like Toronto, in which expansion is fan-shaped, some means of diagonal relief from the heart is most desirable. Travellers may not then have to pass along two sides of a triangle to get to their destination.

We believe that all this is just as patent to yourselves as to us, and we only wish to call attention to it because we consider these diagonal arteries can be made without final liability to the City, and the provision of subways below them would be vastly less expensive than beneath existing streets. Such a scheme of subways is necessarily an alternative to the second and third portions of Scheme No. 1, which has been outlined before, and we think that should there be any actual prospect of these streets being constructed within a short time, they would form the best routes for subways to the north-east and north-west—not only because they pass through the middle portions of the more densely settled sections, but because the construction of the subway simultaneously with that of the street would greatly simplify the process and reduce the cost, and the betterment of neighboring property should liquidate the cost of property condemned.

Comparatively speaking, Toronto is not suffering badly from congestion of street traffic, but while upon this subject of cheapness of construction, we would lay a certain stress upon our well-founded conviction that, for a city desirous of decentralization and of freeing itself from the trammels of congestion, the question of cheapness should not be allowed, in the real ultimate issue, to assume undue proportions.

The primary object of subway construction is to afford freedom for expansion and relief to congestion, and it is generally false economy to avoid the busiest thoroughfares with a view to reducing first cost, and thus hamper the usefulness of the subway for all time. Keeping this in mind, it is our belief that any subway projected should not attempt to avoid main streets with a view to saving costs, but should follow main arteries even at the expense of a certain amount of temporary inconvenience, although such inconvenience is not, as a matter of fact, so great as might be supposed, as it is perfectly feasible to build subways under the busiest streets in the world without interfering with the movement of a single vehicle or pedestrian,—and this has been done time after time in all cities where shallow subways have been built.

The estimate for the subway work in this diagonal street scheme—Scheme No. 3—is $17,700,000, of which the amount for construction of subway and stations is $11,816,000, and that for carrying charges during construction is $680,000.

The following list states the results of the estimates for the various schemes. They include cost of work, equipment, land, contractors' profits, engineering and interest during construction.

SUMMARY OF ESTIMATED COSTS.

Scheme.	Section.	Length in Miles Double Track.	Estimate.	Average Cost per Mile of Double Track.
			$	$
1 (as a whole)	a, b, c	11.645	23,470,000	2,015,400
1 (as three separate sections)	a	2.897	6,100,000	2,105,600
1 (as three separate sections)	b	5.792	11,350,000	1,959,600
1 (as three separate sections)	c	2.956	6,235,000	2,109,300
1	a, b, c	11.645	23,685,000	2,034,000
2	a	3.335	6,762,000	2,027,600
2	b	3.091	5,540,000	1,792,300
2	c	3.468	6,825,000	1,968,000
Viaduct to connect Danforth and Bloor		1.325	2,613,000	1,972,000
3 (as a whole)	a, b, c	13.298	17,700,000	1,331,000

We are desired to report on "the necessary arrangements for handling the traffic, having in mind the present system and the City's right to construct tubes in the central parts and surface lines in the outlying districts." With the exceptions already noted, viz., (a) congestion of Yonge Street; (b) slight lack of number and quality of cars, and (c) lack of transportation to certain districts outside of the single prevailing fare, we consider the arrangements for handling the traffic of present needs are very satisfactory and adequate; but to overcome the fact that a uniform fare does not cover transportation as far as might reasonably be expected, we can only recommend for your consideration, and as a part of the ideal arrangement, the construction of one subway line from the centre of greatest density of traffic to the nearest point of the old boundary line, which necessarily means a line somewhere from City Hall northwards—preferably under Yonge Street or Teraulay or Victoria Streets, as may be thought best—but this line if constructed now, would require the assistance of City funds to carry it, as may be seen from the following article.

Financial Probabilities:

Considering the question as to what financial results subway schemes are likely to obtain, we present to you the two aspects of the case:

(a) That of a Yonge Street subway operated in opposition to the present street railways.

(b) That of the ideal subway scheme we have outlined as Scheme No. 1, and operated in conjunction with the present street railway system, extended into the various district to points about 6 to 8 miles from City Hall.

In the first case (a) the present Toronto Railway Company would still retain the short haul traffic within the City limits. The true function of a subway, we have said, is not so much to take short haul traffic as to move masses of travellers rapidly and cheaply from the congested business area to the surrounding areas of residential districts. A subway such as this competing directly with a surface line must be at a great disadvantage, and a subway has its own needs and its own functions, and by recognizing this and working on those lines alone, success may be assured in many cases, whereas by attempting to compete with the short haul facilities afforded by a surface line, failure may be the result. Apropos of this, it is of course not at all necessary to give any thought to the accommodation of both rapid and local transit in Toronto by a four-track subway.

We have made a study of the amount of traffic now taking place over the various surface car lines, and believe that during the year 1910 about 104,000,000 passengers will be carried on the surface lines in the City of Toronto.

We have also taken observation of the relative number of transfers at the transfer points throughout the City. This information has been plotted diagrammatically, and is shown in Figure 8.

With the above conditions we forecast that on this subway line up Yonge Street in three years' time, which is the earliest date at which such a subway could be put in operation, there would be traffic for the first year of 7,000,000 passengers. We have assumed twenty miles of single track radial lines to be built in conjunction with this subway and operated as a single system on a five-cent fare; the gross income would be $350,000 for the first year. On the basis of a five-cent fare and taking into account this rather insular operation and the unusually long haul per passenger, we estimate the operating expenses would be about 75 per cent. of the gross earnings. On this basis the operating charges would amount to about $262,000 per annum. Taking an average of the cost of the various lines we have outlined on Yonge Street, the cost of construction of the subway part will be $4,500,000; for radials to the extent noted above, $500,000, and for equipment, $7 5.000. The total figure, including interest during construc-

tion and all other charges connected therewith, is $6,310,000. Charges are estimated as follows:

Operating expenses (including maintenance and depreciation)	$ 262,000
Sinking fund on structures at 1 per cent.	40,000
Bonds at 4 per cent.	252,000
Total	$ 554,000

This makes a deficit in the neighborhood of $250,000 on the first year's operation. We think it may be safely assumed that the increase of travel accruing to the independent line would amount to about 10 per cent. per annum up to the time of the termination of the franchise. There is a rough means of checking these figures for operating expenses—for example, on this system we estimate the line would carry about six (6) passengers per car mile; this on the basis of the number of passengers carried as above stated, and at .25 cents per car mile, which we consider proper in this case, gives an operating expense for the year of $292,000.

Having dealt with one scheme to be operated independently of the existing street railway system, it will be sufficient to treat of another operated in connection with this railway. This system will be composed of the subways, the existing street railroads, and additional radial lines outside the City limits, which may be entirely new lines, or partly new lines and partly existing lines absorbed. We estimate the radial lines desirable to act as part of this system would amount to about 40 miles of single track. At the rate of increase of population and travel at the end of four years from this date—which would be the earliest at which such a system could be put into operation—we estimate the number of passengers to be carried on such a system would be about 150,000,000 for the first year. It is presumed the public expect this system to be operated on a five-cent fare with fairly liberal transfer facilities, and on this basis we estimate the gross receipts should amount to $5,000,000 the first year. The total real investment at this date, without regard to the cost of liquidating the street railway investment involved for the remaining seven years to the end of the franchise, we estimate as follows: The entire subway system fully equipped with multiple unit trains, including all charges, such as interest during construction, contractors' profits and engineering, would cost $23,500,000. The real value of the surface railway company's property, say, $15,000,000; the cost of the additional radial lines, say, $3,000,000, and the above cost of construction, make a total cost, exclusive of the purchase of vested interests as above stated, of $41,500,000.

The advantageous layout of this system, with full trains both from east and west to the heart of the City in the rush hours, is such that it is conducive to economical operation. On the other hand a universal five-cent fare with the transfer system combined will necessarily give a higher proportion of operating expenses to total receipts. Combining advantages and disadvantages, and based on considerable precedent, we estimate such a system will be operated at about 65 per cent. of the gross receipts (includes

maintenance and depreciation). This brings operating expenses to a total of $3,250,000, leaving only $1,750,000. This would cover fixed charges should the capital be no more than the real value as we have shown above, but of course to these charges must be added others sufficient to cover the value of the present investment of the street railway company's shareholders for the ensuing seven years. It will readily be seen, however, that if the franchise were terminable in four years' time the system just outlined would be practically self-sustaining.

Assuming the real value as above stated is $41,500,000 in the year 1921, when the franchise terminates, and that the passenger traffic to accrue to the entire system will be—as we estimate it—in the neighborhood of 220,000,000 passengers for that year, the inference is plain, that, as a carefully and economically operated concern it should produce at least moderate surplus.

Depressed Trolley Lines:

Assuming you can co-operate with the present railway company and that it is agreed the number of trolley cars passing along Yonge Street should be greatly diminished or entirely removed from this important thoroughfare, it is possible to depress the tracks immediately under the street for such a distance as might be thought advisable or sufficient. This can be done by constructing a subway under the street with a loop at its southern end and branches leading into the important side streets and rising through portals to the surface at these points. Where these portals exist it would probably be, in some cases, desirable to widen the street for a length of not less than 200 feet in each case. The following diagram (Figure No. 28) illustrates the meaning of this recommendation diagrammatically. Exclusive of the purchase of property where the streets may have to be widened if necessary, the cost of such a structure to accommodate trolley cars, including tracks and stations (100 feet long), exits, entrances and portals, we estimate may be assumed at $310 per foot. The portals would occupy a space in the middle of the streets approximately 21 feet over all by 150 feet to 200 feet long, the latter depending on the grade leading from the street to the subway; which for this short length can be anywhere from 7½ per cent. to 10 per cent. Such an arrangement, of course, if carried out prior to the expiration of the franchise, would have to be done under a special agreement with the Toronto Railway Company. The Council may think it wise to carry the cost of this, with the taxation at present levied on the railway company, who we presume would doubtless be glad to operate it under their present arrangements. This really of course involves added taxation to the public, excepting that the street railway company could afford to pay a rental in view of the superior accommodation afforded by the subway. This subway can be designed to form in the future, if necessary, a part of the other subway schemes.

Admittance of Radials:

In the earlier stages of operation of either the simple Yonge Street subway or the more complete system, single cars from outside radial lines might also enter the subway under agreement; latterly, when the system developed into a busy rapid transit system necessitating, at least in rush hours, the operation of mutiple unit trains, these foreign radials might still (provided their traffic was good enough) continue to operate on the subway line with multiple unit trains. If their traffic was highly intermittent we consider it would be more satisfactory to have an exchange station looped by the radial lines. A very good arrangement for this purpose can be devised as shown on the accompanying diagram (Figure No. 29). This same arrangement could be carried out underground, in which case the surface line loop would be brought underground and below the subway tracks, as the surface line is more flexible as to grade than the subway. Of course there is no reason whatever why subway trains may not continue on the surface for any distance, so long as their traffic justifies it, and for that same reason outside radial lines—i.e., lines not under the management of the subway system—might also use the subway.

We are tempted to refer, before closing this section of the report, to the broad question of the advisability of municipalities engaging in the transportation business. The whole question of "municipal trading," as the municipal management of public utilities has come to be called, is full of difficulties, and a few cities can point to considerable success in constructing and operating such utilities, while many others are burdened with equally considerable failures. Without attempting to go into detail on this part of the question, and realizing that our instructions do not specifically require any comments from us on this point, we feel that nevertheless we would in perfectly general terms express our preference for private operation of such utilities as transportation in and around cities

Transit in cities can be provided under one or other of the following methods:

First: The City building and operating the system under official regulation.

Second: A private company building and operating the system.

Third: The City building the transportation system and letting the right to operate same to an outside corporation.

Fourth: The City giving a franchise to an outside corporation for the construction and operation of the transportation system.

Fifth: The City giving its credit to underwriting bonds in favour of a private company which actually finances and builds, with reversion of ownership to the City provided by a sinking fund.

The relative advantages and disadvantages of these methods may be summed up as favoring the third method, for the reason that the credit of the municipality is generally better than that of the private corporation; it can obtain capital necessary for construction at a cheaper rate of interest, as the bonds issued become a lien on the taxing power of the City, while if an outside corporation should undertake to obtain this capital, they must take the risk of the project's earning its own way, and financiers therefore demand a little greater return owing to the risk involved in this operation; and at the same time the municipality is relieved from any possibility of party politics' influencing the operation in general or the appointment and disciplining of employees engaged on the system.

There is even much in favor of private enterprise's taking hold of the construction, equipment and operation of a public enterprise under official government. These undertakings have been sources in many cases of great extravagance and waste on the part of municipalities. Private capital embarking on such an enterprise is surely worthy of as much return as any individual expects to make from a private business investment, and these enterprises are doubtless a means of income to many that are otherwise unable to engage in commercial life.

It will often be found that private operation, which is usually conducted under vigilant criticism, leads to better service, more economical operation and a more highly strung state of efficiency than most municipally run enterprises. We here refer specifically to the operation of lines of transit, and we believe that a city may most advantageously construct such utilities on its own credit, obtaining money on the lowest possible terms and leasing the working rights to operating companies under careful restrictions.

Even in the case of cost of construction we are aware of more extravagance in the case of municipalities than in the case of private enterprise, as the municipalities are more subject to changes of government, inducing changes of plan during progress of work. It is also more flexible to innocent criticism, and in the endeavor to meet these criticisms mistakes are frequently made in the ultimate design and construction of the utilities concerned.

We bear in mind the fact that the City is now receiving from the Toronto Railway Company about $640,000 per annum, made up of $508,000 as a percentage of the earnings, $82,000 as pavement charges and $50,000 as general taxes most or all of this represents a net income to the City which will probably increase, rather than diminish, during the remainder of the franchise.

Even with the complete system of subway, surface and radial lines we have outlined and believe to be self-supporting by the year 1921, we would not be understood to favor municipal operation, as we are convinced that such operation, even with the best will in the world, is usually incompetent and wasteful and unsatisfactory to the public.

On the one hand, having thus ventured to criticise adversely, as a general principle, municipal operation of such facilities as public railways, we think, on the other hand, that a railway company is ill-advised to confine itself to the strict letter of the law and not extend its lines to within reasonable distances outside any City limits, on the ordinary fare, when it is more or less evident that owing to the conformation of the City, good business can be obtained at points nearer the business centre from which the travel radiates. A broader policy on the part of a private company brings not only, in cases like this, the good will of the public, but almost invariably better financial results, at least in the long run.

Finally, we think you will agree it is nevertheless easier to control or regulate a private company than to control municipal operation with ever changing government.

Description of Subway Suggested:

The drawings appended herewith, Figures 14, 15, 16 and 17, show typically the general features of the kind of structure we would recommend for adoption in Toronto, when decision to proceed with the provisions of exclusive traffic facilities is reached.

It will be seen that the structure is of reinforced concrete, which is not only cheaper than one of structural steel, but we believe it gives a lower temperature in the subway in summer than a structure containing exposed steel work.

Ventilation is assisted by having a separate compartment for each track, a medial curtain wall being placed between them. The trains themselves thus maintain a constant current of air in the direction of the traffic. This is most important from the point of view of comfort to passengers.

Ease of access is provided by keeping the subway as near the street surface as possible, and the structure would be in general entirely below the existing street.

Two sets of typical designs are included—one set showing a height of 12 feet 9 inches from top of rail to under side of subway roof. This height is enough for the proposed subway car with third rail, which we also show in another drawing. The other set of plans shows 14 ft. 0 in. clearance between the top of rail and under side of subway roof. This is enough to admit the present surface line cars within the subway, should it be desirable to so admit them. The estimates we furnish are based on the adoption of this higher type of subway. This structure will cost approximately about 5 per cent. in excess of that required for the third rail subway alone.

We strongly recommend the provision of accommodation for as many public utilities as possible, such as water mains, electric cables, and so on, within an adjunct to the subway if constructed. Rentals might be obtained from some of these utilities, and the City would further gain the advantage of lessened disturbance of the streets when it was necessary to gain access

to these, and further the unsightly poles and overhead wires would be removed. This provision would not add materially to the cost of the structure.

We recommend that wherever possible the entrances and exits to and from the surfaces of the streets and the subway be made—by arrangement with the property owners—through buildings, and not by means of stairways from the sidewalks. These stairways are always the cause of much obstruction on busy sidewalks; and an entrance through a building, especially if the building be a store—as on this continent is generally the case at a busy street corner such as is usually chosen for a station site—is a mutual benefit both to the subway and to the property owner, as such an entrance brings business to both, and show windows can be placed in the station. It is usual in such cases for the subway to bear the expense of the necessary alterations to the building, while the owner gives the subway a free right-of-way and user.

The general type of intermediate station we would recommend has two tracks and two outside platforms. For terminal stations we favor the stub-end type, for though the loop has its own advantages it is much more costly, requiring a much larger area, while the stub-end type is much better adapted to future extensions. For very busy terminal stations it is advisable to provide, in addition to outside platforms, an "island" platform between the tracks, enabling trains to unload from one side and load from the other. The stations are spaced at what are believed to be the most convenient points, and are those that should have the maximum amount of interchange with the surface lines.

Capacity of Subway:

The maximum capacity of the subway under the most extreme conditions of traffic that can be expected to take place in Toronto for many years to come, is entirely adequate. It may be stated in terms of modern practice that the subway is capable of carrying from 25,000 to 30,000 passengers per hour in one direction. As at present designed and estimated for in the plans we submit, the stations are long enough to admit of half this capacity, but the grades should be laid out so that the stations, to accommodate longer trains, can be extended to at least twice this length and thus attain the capacity mentioned.

Stations are designed to be 150 feet long, which will be enough to operate three-car and even four-car trains. The width of the platforms is 10 feet, with stairways to the surface.

Rolling Stock:

The car proposed as suitable for use on the subway is shown in Figure 18 and has the following general dimensions:

Length over all	50 ft. 0 in.
Width outside	8 ft. 11 in.
Height, top of rail to roof	12 ft. 0 in.
Centre to centre of trucks	34 ft. 4½ in.
Diameter of wheels	2 ft. 10 in.
Wheel base, motor end	6 ft. 6 in.
Wheel base, trailer end	5 ft. 6 in.
Seating capacity	48 persons
Standing capacity (comfortable)	52 persons
Total capacity	100 persons
Approximate weight	30 to 35 tons

These cars have a steel body, cement floor, and three doors on each side, giving rapid loading and unloading Further they may be designed for use with the overhead trolley system on surface lines extending into the suburbs.

Track;

We have carefully considered the track question as it relates to the provision of new means of transportation which may be provided.

We regret to see the track gauge in use in and around the City is not uniform, and we see that at present conditions are as follows:

	Gauge.
1. Toronto Railway (i.e., all lines within the City)	4 ft. 11 in.
2. The Toronto and York Radials.	
(a) Metropolitan Division	4 ft. 8½ in.
(b) Scarborough Division	4 ft. 10⅞ in.
(c) Mimico Division	4 ft. 10⅞ in.
3. Toronto Suburban Railway	4 ft. 10¾ in.
4. The Grand Trunk Railway	4 ft. 8½ in.
5. Canadian Pacific Railway	4 ft. 8½ in.

We believe that this complication of gauges is inimical to the proper future growth of traffic facilities and that some uniform gauge should be adopted, so that the rolling stock of one system should be able to pass over any line of tracks. In doing so we are looking forward to the time when all rapid transit facilities of the district and City will be under one government and with as much inter-transfer as possible between the now different systems. It therefore becomes a somewhat serious question as to what

gauge to recommend for any new subway. We have come to the conclusion that it is wise to propose the use of the standard 4 ft. 8½ in. gauge on any new subway, and we do so for the following reasons.

(a) It is the gauge of the steam railways, which cannot alter their gauge, and it might be desirable to run the subway cars on the steam lines.

(b) It is the gauge of the Metropolitan Division of the Toronto and York Radials, and we believe that most development will occur along this line.

(c) It is the standard gauge most commonly is use, and all equipment, etc., can thus be more readily and cheaply obtained.

We are not unmindful of the fact that for a free interchange this involves the ultimate change of gauge of all the existing lines with the exception of the Metropolitan Division, but we believe it will make ultimately for increased facility and economy of operation. However, should it be considered that the alteration of the present gauges be a too expensive task even with a view to obtaining ultimate benefit, then we would recommend the adoption for the subway of the 4 ft. 11 in. gauge of the Toronto Railway and alter the radial lines' gauge to this.

Ventilation:

It is possible that during hot weather the natural current of air in the direction of traffic induced by the movement of the trains may need some augmentation. In this case exhaust fans can be installed at suitable points at a not heavy charge, to discharge vitiated air, which will be naturally replaced by fresh.

Signalling:

We have allowed in the estimate for the installation of block signals equipped with devices for automatically throwing on the air-brakes in case a train should run past a signal set at "danger." The signals would be spaced so that a train would be brought to a full stop before the train in front was reached. The signals would be spaced so that a three-minute headway would be maintained. When the growth of traffic makes it necessary, the installation of additional signals will permit of this headway's being reduced to one and one-half minutes. Junctions and switch-points would be protected by interlocking signals, arranged to prevent any conflicting movement.

It may be said that the installation of an elaborate system of signals within the subway is not absolutely necessary, and that if single surface cars are first used only, a much less complicated system might be employed. This would mean a reduction of about 1 per cent. in the first cost. However, we have assumed in these estimates that you would prefer to operate the subway under the best possible equipment.

General Notes on Estimates:

In making the estimates allowance has been made for maintaining the street railway tracks during traffic, so that no interference with operation will be caused.

We have stated the geological conditions are in general favorable to rapid and cheap construction.

Summary of Conclusions;

The following are the main conclusions to which our study of Toronto conditions has led us:

A—Vehicular Traffic:

What congestion exists in the vicinity of the lower end of Yonge Street can be ameliorated to a certain extent by the regulation of vehicular traffic—particularly the prohibition of certain streets in this district to trucks, especially during the rush hours.

B—Street Car Traffic.

(1) For any communication within the City limits the present service is adequate, with the following exceptions:

(a) Too many cars use the lower end of Yonge Street, and we recommend that some of the present routes in this vicinity be changed into the nearest possible parallel streets, or that a subway be provided by which the cars in Yonge Street may be depressed below the surface.

(b) The supply of cars is hardly adequate on some of the routes in the rush hours, and we recommend that additional cars be provided to remedy this.

(c) Some of the cars are lacking in comfort, and especially so in the case of trailer cars. We recommend this defect be remedied.

(2) For connection with outlying districts the present service is not adequate, and this acts disadvantageously to the interests and growth of the City.

C—Suggestions for the Future:

(1) Serious attention should be given to the question of construction of the proposed diagonal thoroughfares, together with simultaneous construction of subways beneath them.

(2) We are convinced that before the lapse of twenty years Toronto will feel acutely the need of some means of exclusive traffic.

(3) We recommend that this provision should take the form of subways of shallow depth, comprising an east and west route and a north and south route.

(4) We recommend for present consideration the north and south route only, with consideration of the east and west held over pending decision as to the diagonal thoroughfares.

(5) We do not think that this north and south subway route would prove self-sustaining if operated in competition with, or in opposition to, the present surface lines; nor do we believe that any subway system would, thus operated, serve the best interests of the public, as if it is to act as a distributor and collector within the City limits the time of transit will be little better than on the surface lines, and in would in most cases lead to payment of a second fare on the surface lines.

(6) We are convinced that the entire subway system as outlined, if operated in conjunction with the surface lines, including both those within the City limits and those outside (including new radials to districts at present unserved) if operated under one management, would be self-sustaining and even profit-returning by the year 1921, as well as of great benefit to the growth and convenience of the City, and that—on the basis solely of physical valuation—it would be self-sustaining even now.

(7) We recommend that if subways be favorably considered, the City's credit be pledged, but only for their construction, and that the equipment and operation be let to an outside operating company under suitable safeguards. We further recommend that if this be done the operating company be not so heavily taxed as to strain its prospects of paying a good return.

(8) We are opposed in general to the municipal operation of transit facilities, and are in favor of all these facilities being operated by one corporation under official regulation.

(9) The Yonge Street subway, if constructed ahead of the other parts of the system, should be designed to carry radial surface cars as well as its own special rolling stock. While subway traffic was being built up surface cars would operate through it in addition to its own stock. After traffic in the subway had sufficiently developed it would carry its own stock exclusively, and passengers would be required to transfer to the surface cars at the terminals, or the multiple unit subway trains might also be run on the surface as far as traffic justifies it, with a terminal or terminals elsewhere.

(10) The whole system should be of one track gauge—preferably the standard, 4 ft. 8½ in.

(11) We recommend that, following any decision by the City to construct any subway, the City should offer to the present Toronto Railway Company an extension of their franchise for a further term, commencing at such date as the subway to be constructed shall be ready, under which franchise it should be provided that the railway

company should build or acquire such additional surface lines within and without the old City limits as the City might require, and should take over and operate any such subways as the City may construct; and that failing in the ability to execute such an agreement, then we recommend that the City should acquire as early as possible, or certainly at the expiration of the present term of the franchise of the Toronto Railway Company (namely in 1921), all existing franchises, in order to carry out and co-ordinate a comprehensive system to be offered to some other operating company which will operate the system as a whole.

(12) Consideration should be given to the possibility of assisting the financing of this work by assessment levied on property served by the radial routes.

(13) On the radial lines efforts may be made to build up freight business in addition to passenger, though it is a commercially doubtful factor in systems now conducting a night freight service.

(14) We recommend you should appoint from your Council a permanent Board of Transit to safeguard this important phase of your City's development.

In conclusion we beg to say that the growth and standing of cities are enormously dependent upon adequate transit facilities—more so probably than most people realize. Many may consider you are ahead of the time in thinking of providing exclusive transit facilities, and this we will grant if we are to judge by the case of several cities that are at present suffering from inadequate or badly planned transit facilities. Provision for adequate transit facilities, in the same way as provision for sound education, tends to the uplifting of a large community.

This report is self-contained, embodying all plans and diagrams referred to in the text. In some cases, however, the scale of the plans herewith is rather small, and in such cases reference may be made to larger drawings that accompany the report under separate cover.

We include certain appendices that illustrate in a comparative manner certain of the rapid transit situations in various cities. (See Figs. 19, 20, 21, 22, 23, 24, 25, 26, 27, 30, 31, 32 and 33.)

May we be permitted in conclusion to express our thanks to yourself, the members of the Council, and the officers of the Corporation, especially the Chief Engineer, for information and data promptly and courteously afforded?

Yours respectfully,

JACOBS & DAVIES, INC.

JAMES FORGIE,

M.I.C.E., M. Am. Soc. C.E.

Appendix I.

Figure 19:

This is a table giving statistics as to city passenger traffic in various cities.

It chiefly shows the influence of the amount of traffic and population on the revenue per car-mile of single track and per passenger car.

The columns "Philadelphia Exclusive" and "Boston Exclusive" refer to the subway and elevated lines only, while those headed "Philadelphia-All Lines" and "Boston-All Lines" refer to all the means of transit operated by the companies in those cities—surface, elevated and subway.

Appendix II.

Figure 20: Load Line Diagram—Greater New York.

This diagram shows in a clear form the increase in passenger travel in Greater New York from 1884 to date. On it is indicated the increasing number of rides per head of population per annum, and it clearly shows the effect on the various lines of new facilities afforded—for example, see how the travel on the elevated railroad increased steadily till 1893, which then remained stationary with a decrease around 1899, until 1903.

This was due to the fact that this system had about reached its limit of capacity under steam locomotive operation, and also to the fact that during this period the surface lines were being electrified and they attracted traffic from the elevated. The big increase between 1903 and 1904 marks the completion of the electrification of this system with an increase in the quality of the service and capacity for handling traffic. Since 1904 the elevated traffic has been about stationary, the subways having been opened in 1904 and taking what growth would have had to go on the elevated and the surface lines.

Appendix III.

Figure 21:

This shows the monthly number of passengers carried on the Hudson and Manhattan Railroad tunnels in New York City from the date of opening in March, 1908, to June 10th, 1910, and also the number of passengers per car-mile.

Figure 22:

This shows the total daily traffic in the Hudson and Manhattan Railway for one week, viz., from May 15th to May 21st, 1910, and also on Memorial Day, May 30th, 1910.

Figure 23:

This gives a comparison of statistics for the Toronto and Montreal Street Railways.

The two systems exhibit curves which are so strikingly similar that it has been thought of interest to include this figure.

Appendix IV.

Figure 24:

This is a curve showing the statistics of the Toronto Railway, including an estimate of the yearly number of passengers up to 1921.

Figures 25, 26 and 27:

These are three similar curves showing the daily traffic into the central area of London, and they exhibit graphically the concentration of traffic into the morning and afternoon "rush hours." The service on a system must be designed to deal adequately with these peaks on the load line. It is a somewhat curious fact that in most cities there is a rather definite relationship between the total number of passengers travelling per diem and the number travelling during the rush hour. This relationship is as follows:

There is transported during the hour of maximum travel in one direction in most cities between 10 per cent. and 12 per cent. of the total daily traffic in both directions in those cities.

Appendix V.

Figure 30:

This is a diagram showing the average hourly traffic on the Hudson and Manhattan R. R., New York, between Hoboken and 23rd Street, during December, 1908, for weekdays, Sundays and Christmas Day.

Figure 31:

This gives the average hourly traffic on the Hudson and Manhattan R. R., New York, between Hoboken and New York during September, 1908, for weekdays, Sundays and Labor Day.

Figure 32:

This gives a comparative diagram of the hourly percentages of the total daily travel on the Hudson and Manhattan R. R., New York, between Hoboken and 23rd Street, for the months of September and December, 1908, divided into weekdays, Sundays, and Labor and Christmas Days.

Figures 33 and 34:

These give the same information as Figure 32, except that the travel is between New York and Hoboken.

These two last figures illustrate the relationship between the total number of passengers travelling per diem and the number travelling during the rush hours, as mentioned when referring to Diagrams 25, 26 and 27.